Announcements

- Homework for tomorrow…
  (Ch. 25, CQs 3 & 4, Probs. 2, 10, & 11)

- PHYS 132 labs begin *NEXT* week!

- Office hours…

  MW 10-11 am
  TR 9-10 am
  F 12-1 pm

- Tutorial Learning Center (TLC) hours:

  MTWR 8-6 pm
  F 8-11 am, 2-5 pm
  Su 1-5 pm

Chapter 25

Electric Forces & Charges

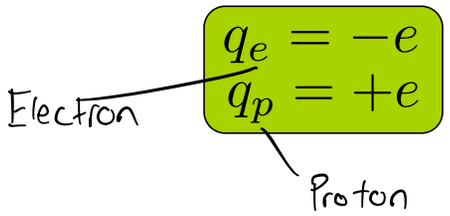
(Charge & Insulators and Conductors)

- Charge
- Insulators
- Conductors
- Polarization

Charge, continued…

Notice:

- charge is an *inherent* property of electrons and protons.
- *Fundamental* unit of charge:



where e = 1.6 x 10^{-19} C

- SI Units: Coulomb (C)
  - 1C is a *huge* quantity of charge

Charge, continued…

The *net charge* of a macroscopic object is..

$$q = (N_p - N_e)e$$

where N_p and N_e are the # of protons and electrons.

- A *neutral* object has q = 0 (but still contains charges!)
- If $N_p > N_e$, then *positively* charged,
  if $N_p < N_e$, then *negatively* charged.

Notice:

- charge is *quantized*!
  - object's charge is always integer multiple of *e*.
- *ionization*:
  - process of adding (or removing) electrons from an atom.

Charge, continued…

Law of conservation of charge

Charge is neither created nor destroyed. Charge can be transferred from 1 object to another as electrons and ions move about, but the *total* amount of charge remains constant.

- So, where did the charge on the rubber rod come from?

  – The Fur

Conductors & Insulators

Conductors…

i.e. metals

- have outer (valence) electrons that are *weakly bound* to the nucleus and free to move around.
  - *"Sea of electrons"* permeating an array of positively charged ion cores.
- allow an *introduced* charge to *flow freely* and *redistribute*.
- Charges in an isolated conductor are in ***electrostatic equilibrium*** (at rest with *zero* net force acting on them).
  - excess charge on a conductor resides on it's surface.
  - charges tend to bunch up in "pointy" regions.

Conductors & Insulators

Insulators…

i.e. glass, rubber, paper

- have electrons that are *tightly bound* to the positive nuclei and NOT free to move around.

- *confine* an introduced charge to the introduced location.

Quiz Question 1

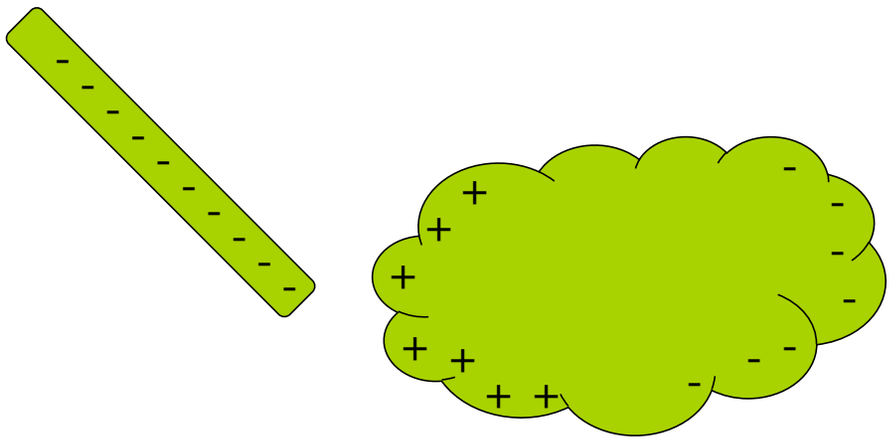
A *negatively* charged rod is brought near a *neutrally* charged conductor.

As a result, the rod will:

1. attract the conductor.
2. repel the conductor.
3. exert no net force on the conductor.

Charge Polarization…

- is a *slight* separation of the + & - charges in a *neutral* object.



- *e*-'s will shift towards the other end of conductor leaving a net + charge on the near end.
- opposite charges attract.
  - The rod experience's a force due to the conductor (& vice-versa via Newton's 3rd law) -> ***Polarization force***.

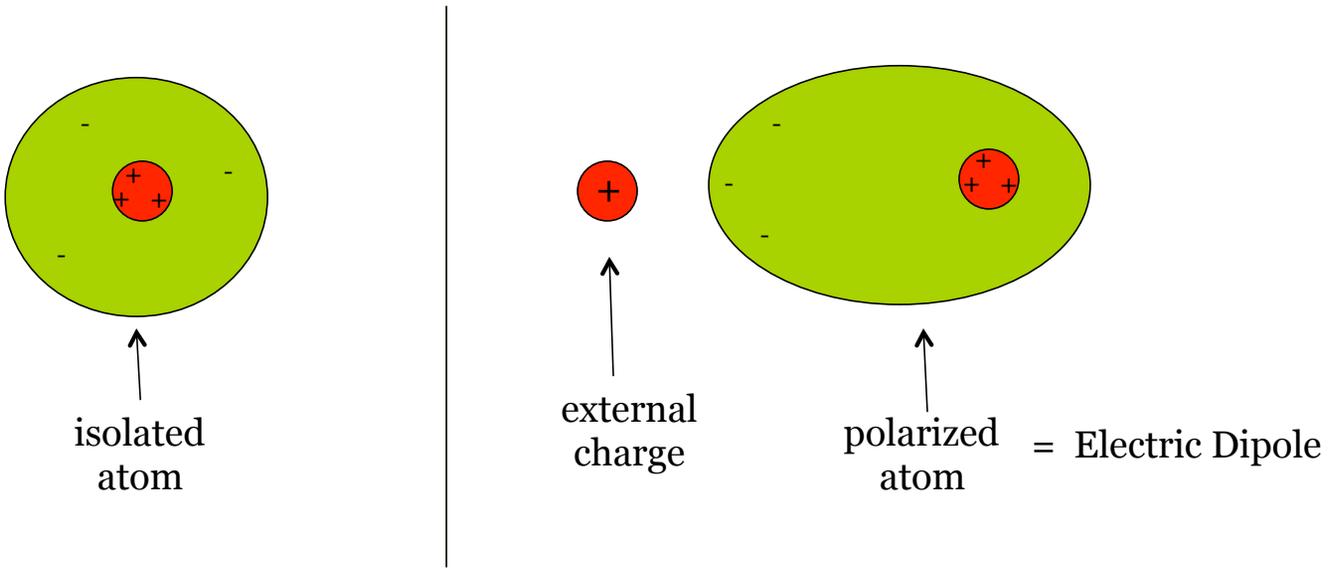
The Electric Dipole…

Q: How does a charged rod pick up shredded paper (*insulator*)?

The Electric Dipole…

Q: How does a charged rod pick up shredded paper (*insulator*)?

- A: The charged rod *polarizes* the atoms!



- What happens if I use a *negatively* charged external charge?

Quiz Question 2

Three pith balls are suspended from thin threads. Various objects are then rubbed against other objects (nylon against silk, glass against polyester, etc.) and each of the three pith balls *may have been* charged when touched by one of the various objects.

It is found that pith balls 1 and 2 *repel* each other and that pith balls 2 and 3 *repel* each other. From this we can conclude that

1. 1 and 3 carry charges of opposite sign.
2. 1 and 3 carry charges of the same sign.
3. all three carry the charges of the same sign.

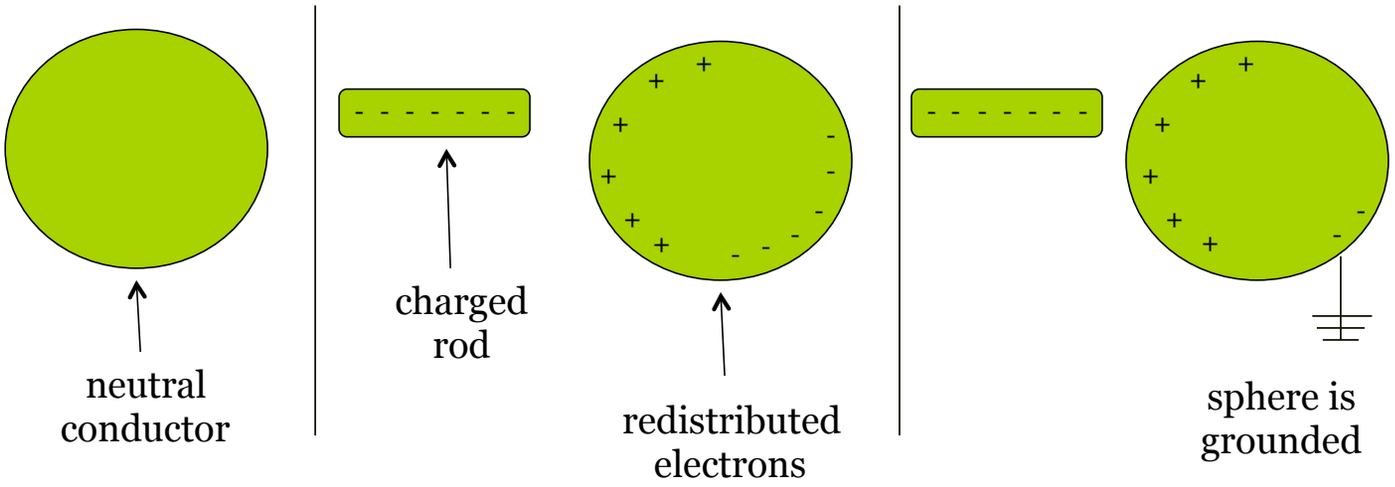
Quiz Question 3

Three pith balls are suspended from thin threads. Various objects are then rubbed against other objects (nylon against silk, glass against polyester, etc.) and each of the three pith balls *may have been* charged when touched by one of the various objects.

It is found that pith balls 1 and 2 *attract* each other and that pith balls 2 and 3 *repel* each other. From this we can conclude that

1. 1 and 3 carry charges of opposite sign.
2. 1 and 3 carry charges of the same sign.
3. all three carry the charges of the same sign.
4. one of the objects carries no charge.
5. we need to do more experiments to determine the sign of the charges.

Charging a conductor by *Induction*…



- When sphere is grounded, some of the electrons leave.
- When the ground & charged rod are removed, the conductor has a *net charge*.

Notice:

- The conductor has been charged *opposite to that of the rod*.

Quiz Question 4

Metal spheres 1 and 2 are touching. Both are initially neutral.

a. The charged rod is brought near.
b. The spheres are separated.
c. The charged rod is then removed.

Afterward, the charges on the spheres are:

1. Q_1 is + and Q_2 is +.
2. Q_1 is + and Q_2 is –.
3. Q_1 is – and Q_2 is +.
4. Q_1 is – and Q_2 is –.
5. Q_1 is 0 and Q_2 is 0.